AMBON

Arctic Marine Biodiversity Observing Network

Demonstration project for an observing network to monitor biodiversity in the Arctic from microbes to whales

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Marine Biodiversity Observation Network (MBON)
All-Hands Meeting
Silver Spring, Maryland
3 May 2016

Goals

1. Apply end-to-end approach in biodiversity observations: microbes, phytoplankton, zooplankton, infauna, epifauna, fish, marine mammals and birds

2. Incorporate environmental data collections (chlorophyll, nutrients, water mass indicators, sediment characteristics)

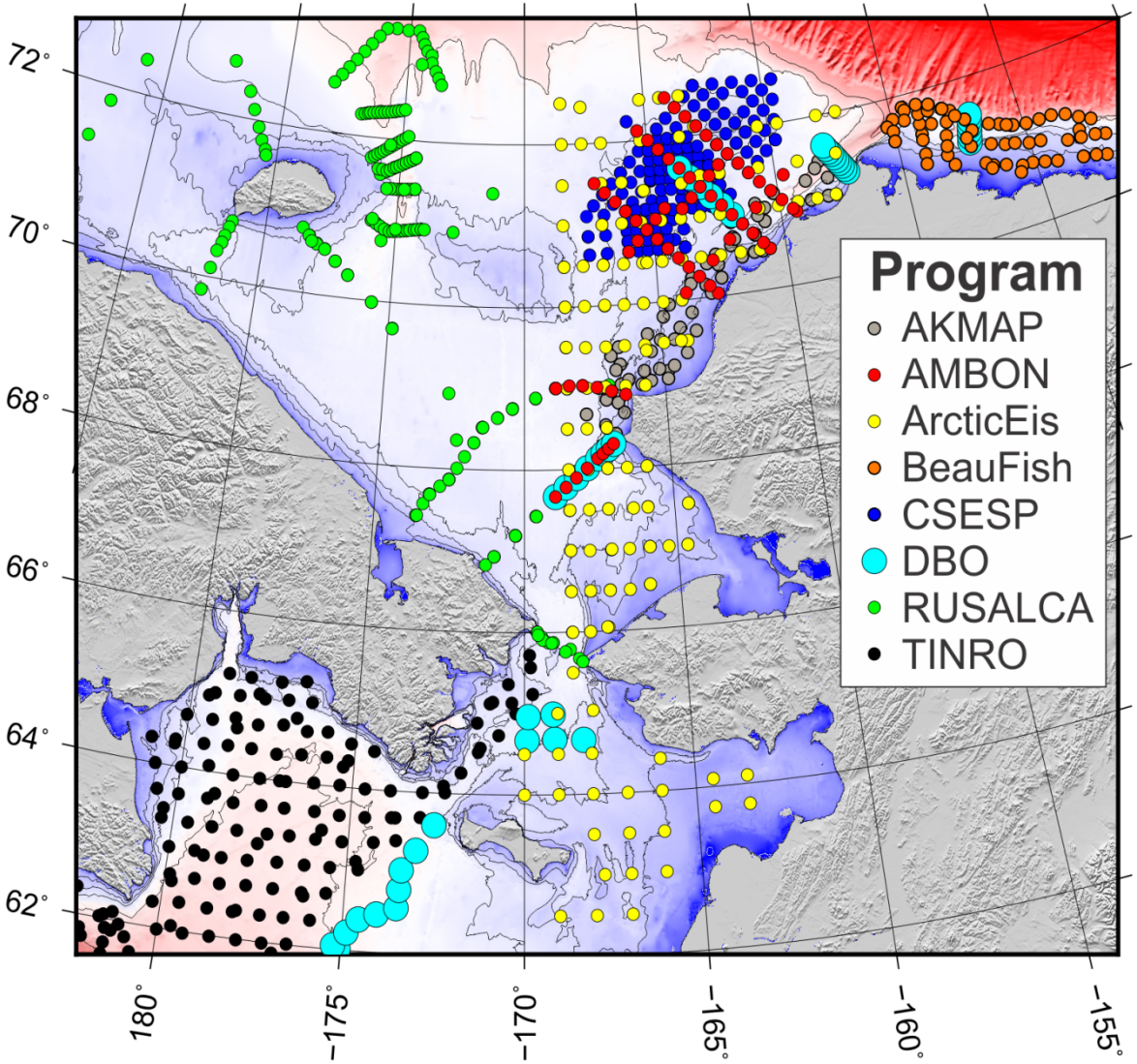
3. Continue existing time series and close current gaps in taxonomy

4. Integrate and synthesize with past and ongoing research programs in the Chukchi Sea

5. Demonstrate practical metrics for a sustainable observing network for the Arctic and other regions

Arctic biodiversity from microbes to whales

The Arctic Chukchi Sea



Key Points

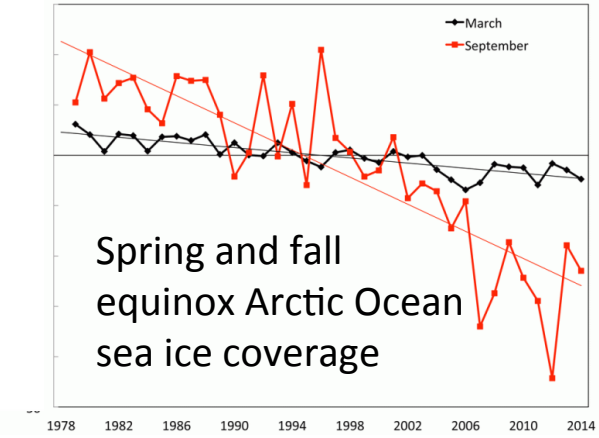
Among largest continental shelves globally

Strong south-north gradients

Distinct water masses

Region of dramatic sea ice changes

Historical biological and oceanographic data available



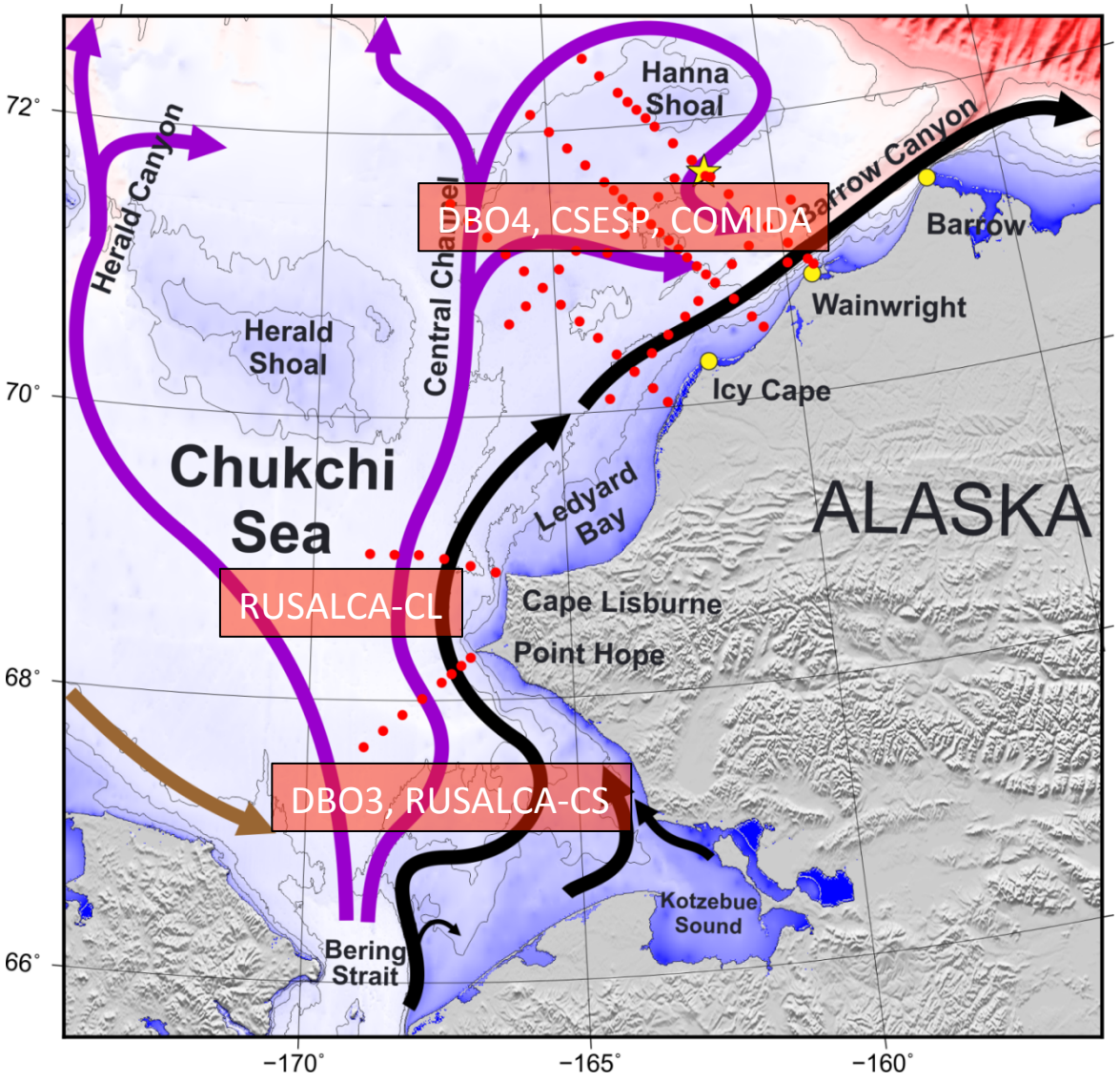
AMBON sampling region

1st field effort in 2015

RUSALCA: Russian-American Long-Term Census of the Arctic (NOAA)

CSESP: Chukchi Sea Environmental Studies Program (industry)

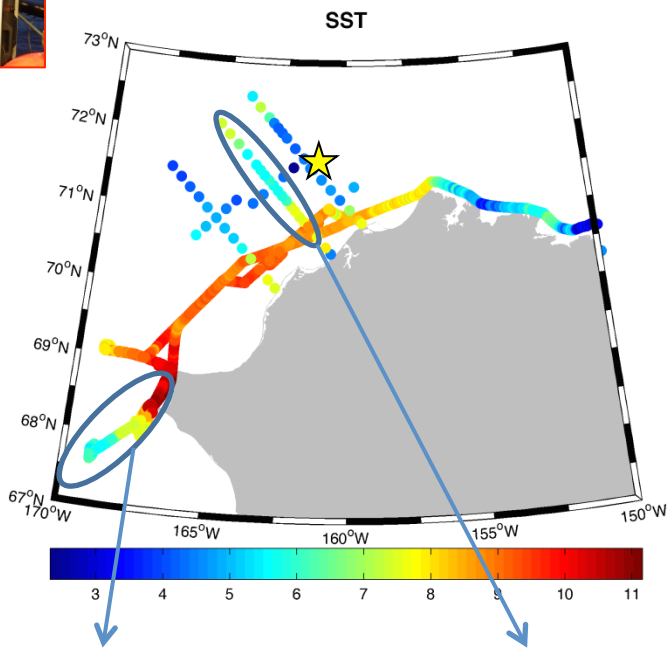
COMIDA: Chukchi Sea Offshore Monitoring in Drilling Area (BOEM)

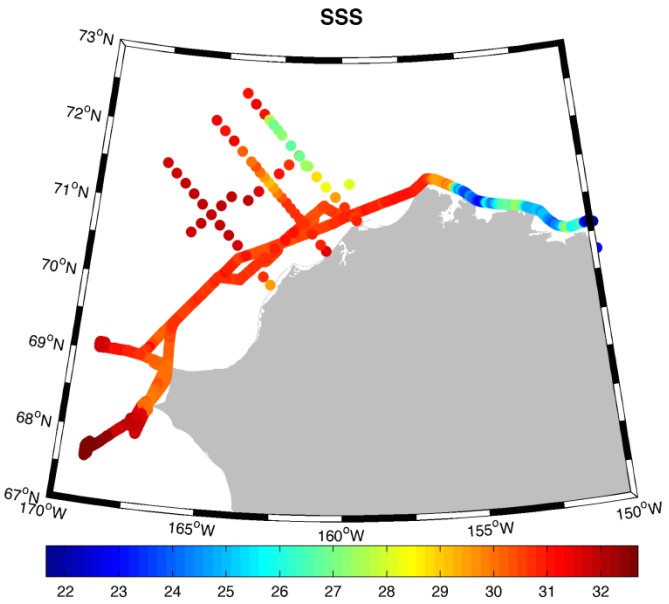


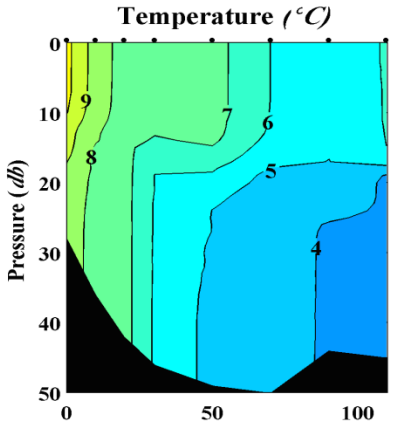
DBO: Distributed Biological Observatory (NSF, other agencies and international partners)

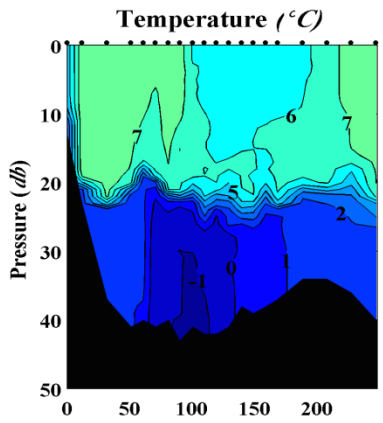
Hydrography

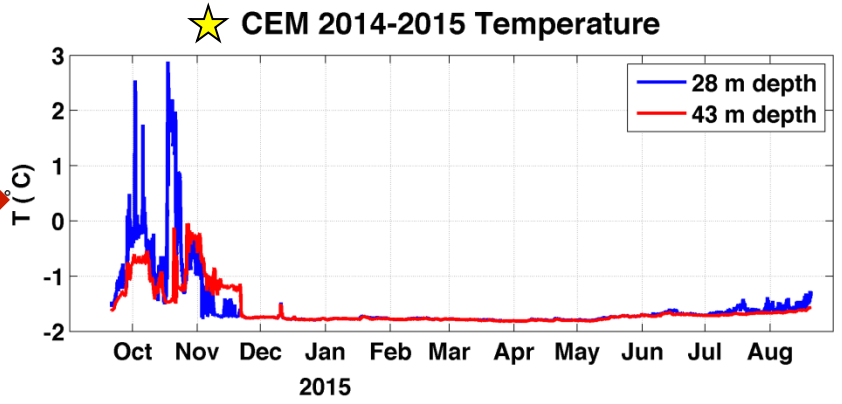
2015









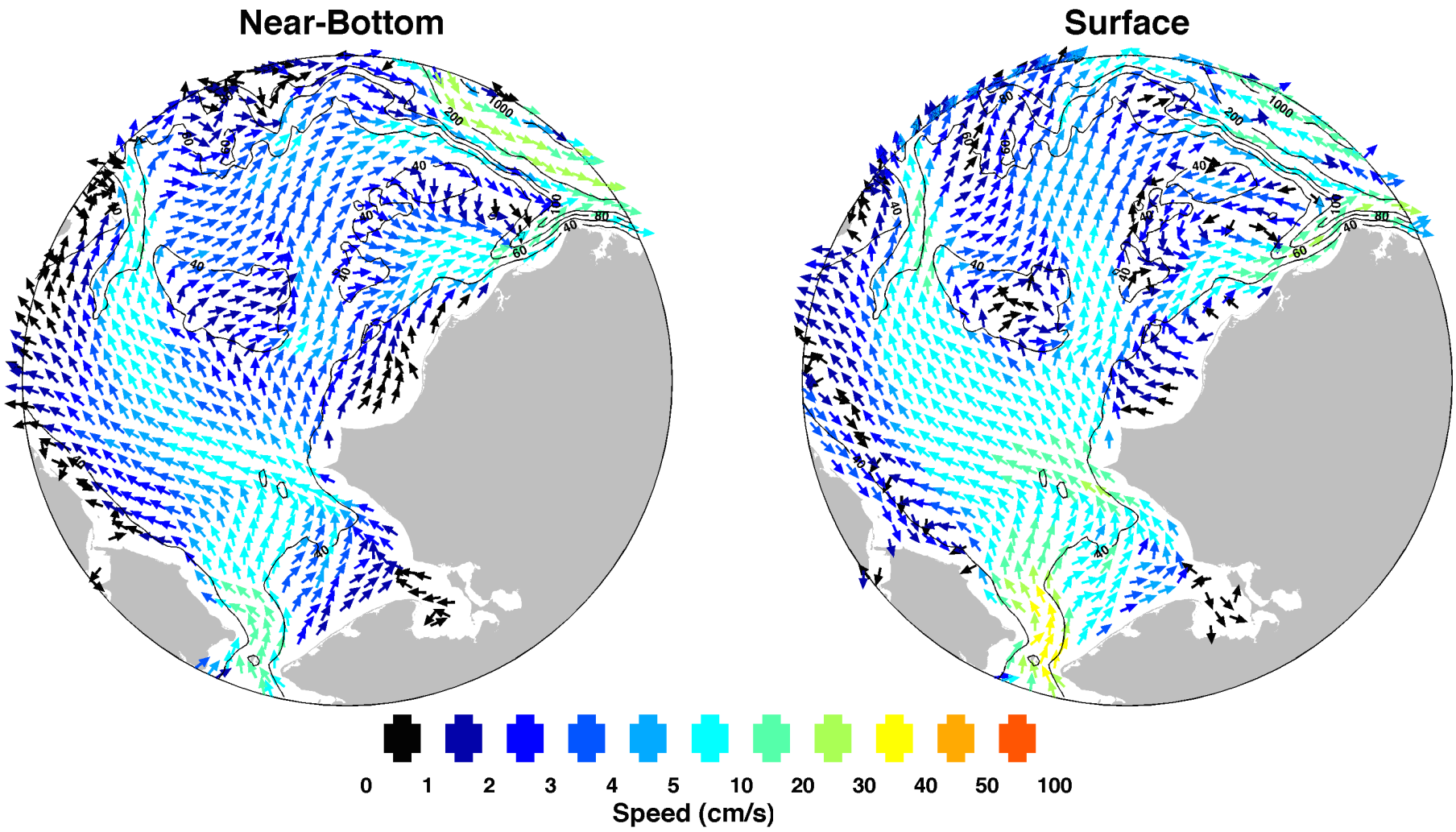


Inshore-offshore gradients

Vertical stratification

Long-term data records (mooring)

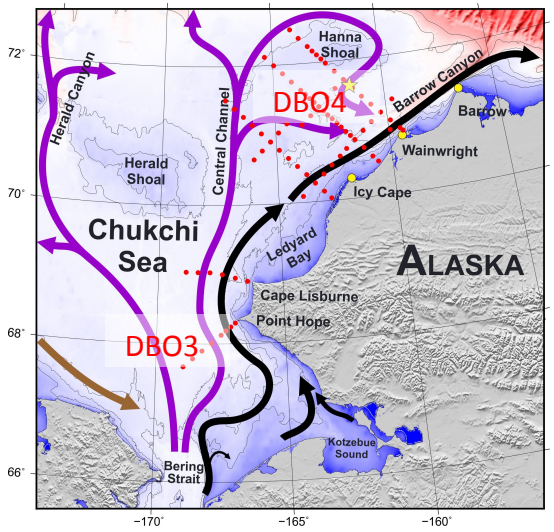
Seth Danielson Modeling

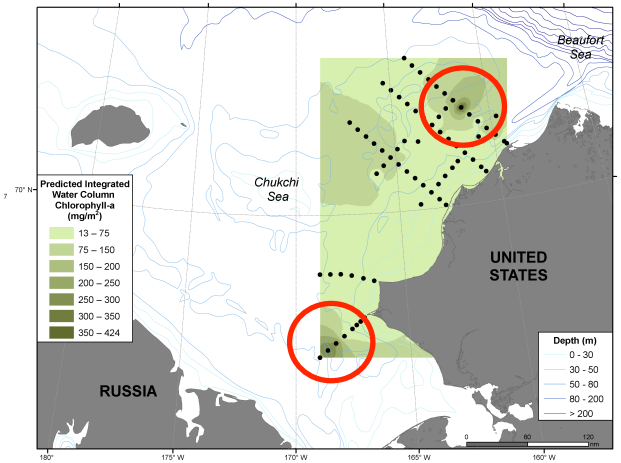


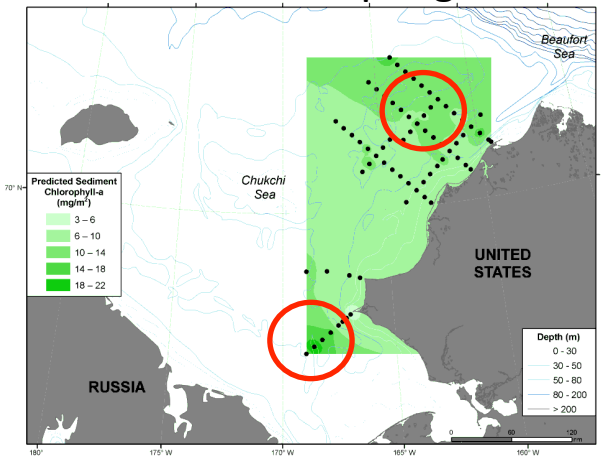
AMBON 2015 Cruise: August-September

Chlorophyll and nutrients

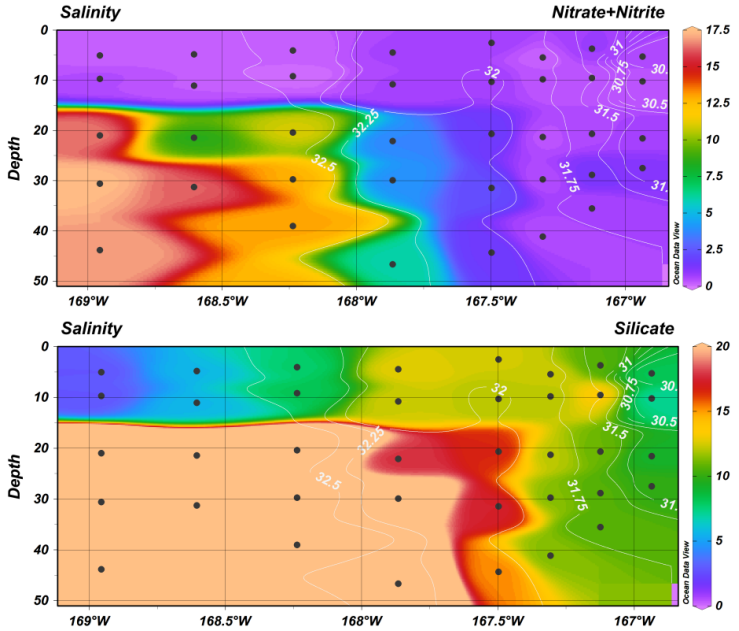
○ "Hot-spot" Pelagic – benthic coupling



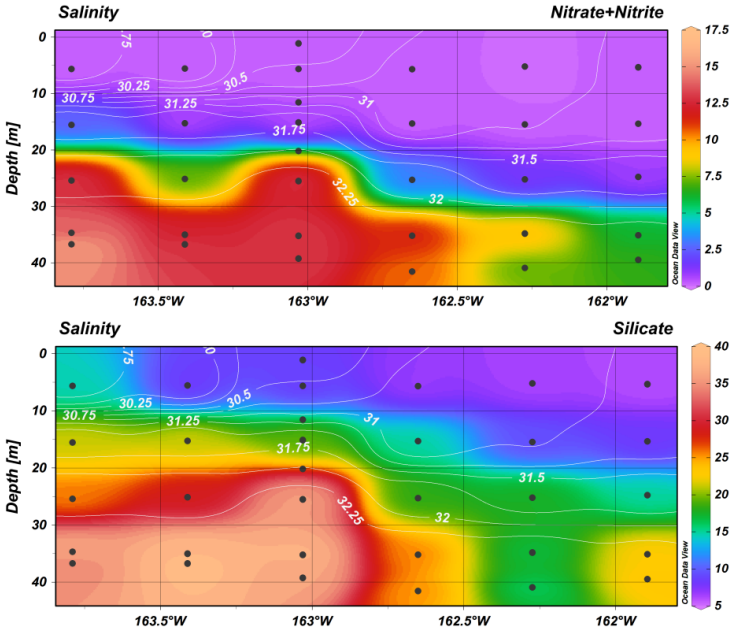




- Integrated water column chl *a* (left) and sediment chl *a* (right)

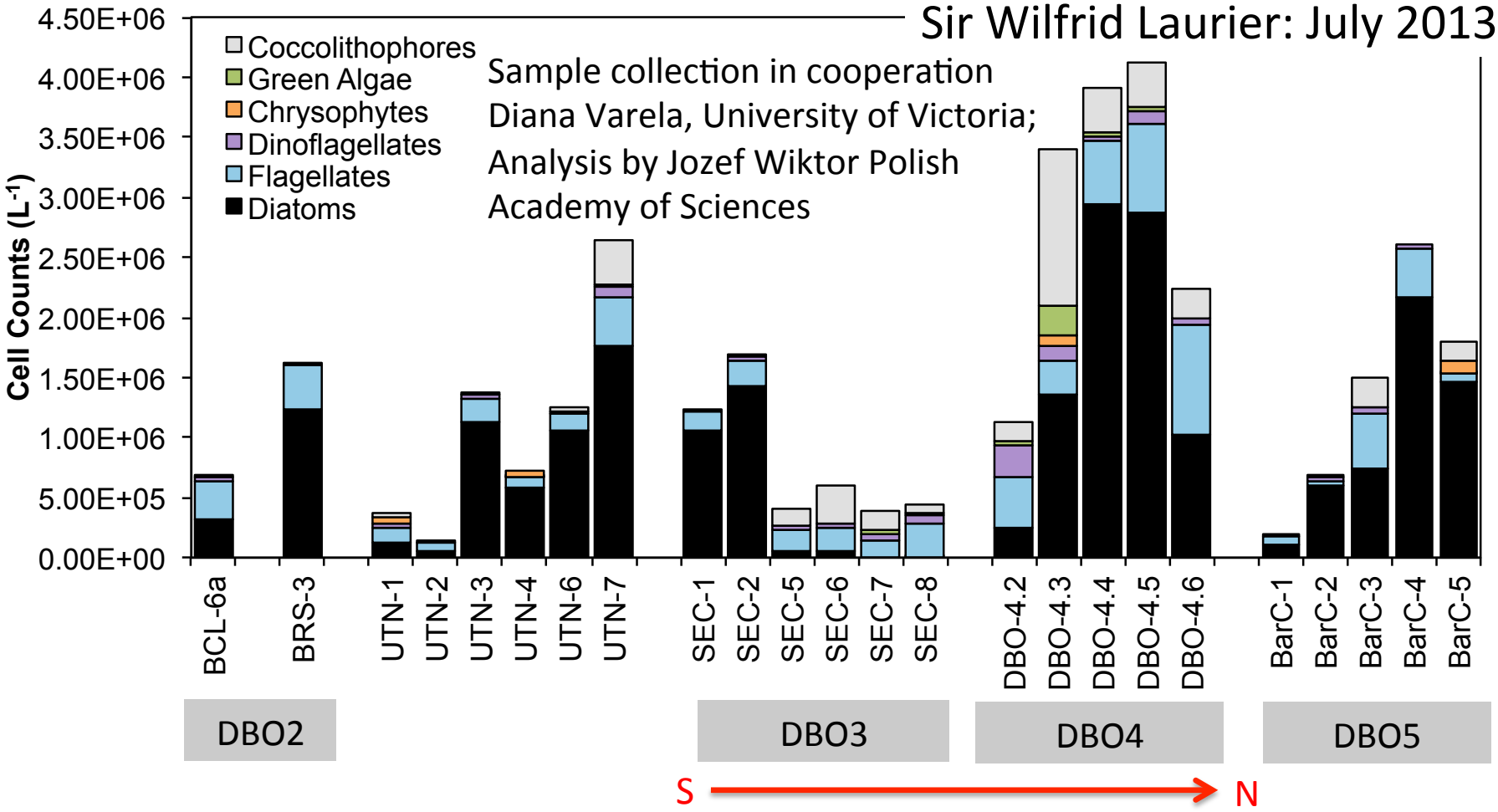


- Water column nutrients at DBO3 (left) and DBO4 (right)- August 2015



[funding through NOPP from NOAA, BOEM and Shell Oil]

Phytoplankton Diversity AMBON and DBO Data Products (in progress for 2015)



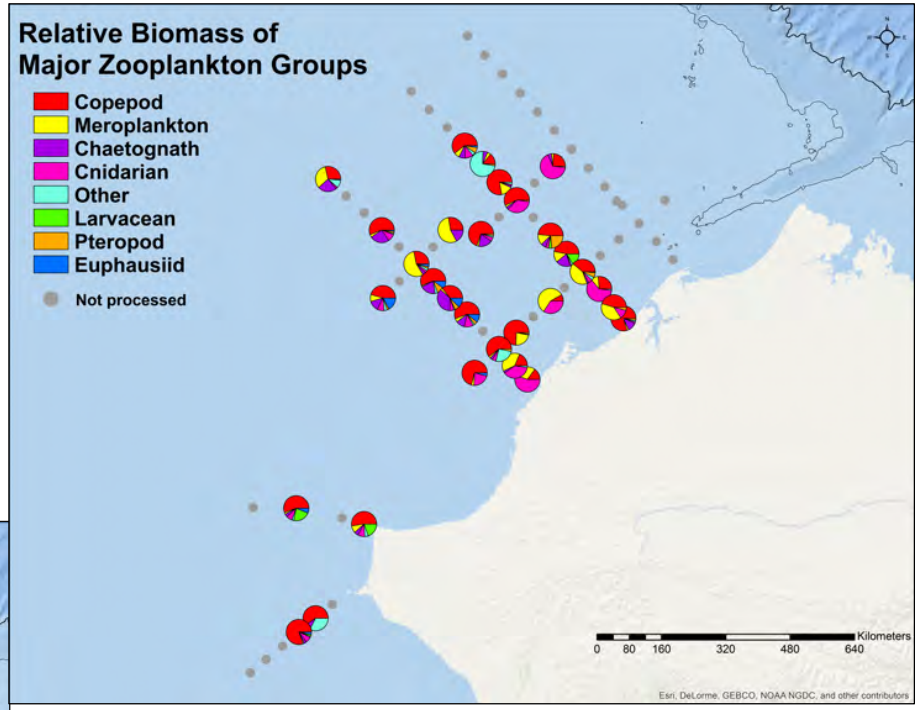
- Phytoplankton taxonomy, with dominance by diatoms in western side maintained by nutrient rich Anadyr and Bering Shelf waters

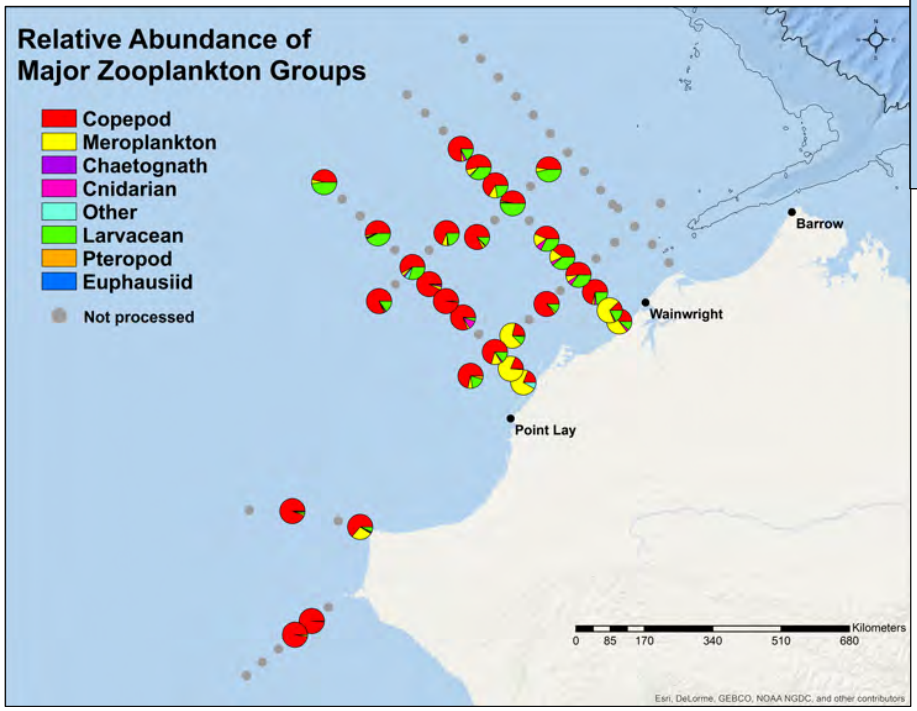
AMBON 2015 – Zooplankton Progress Update

Dominated by small-bodied copepods numerically: *Oithona similis* and *Pseudocalanus* spp.

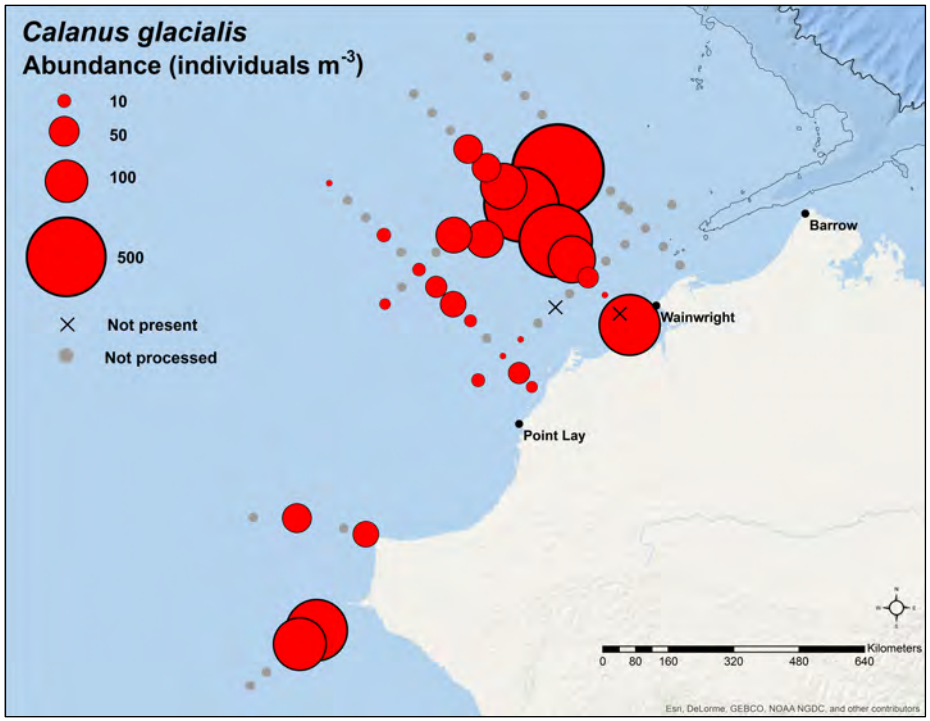
Predatory chaetognaths and cnidarians make important contributions to biomass, as do large-bodied copepods

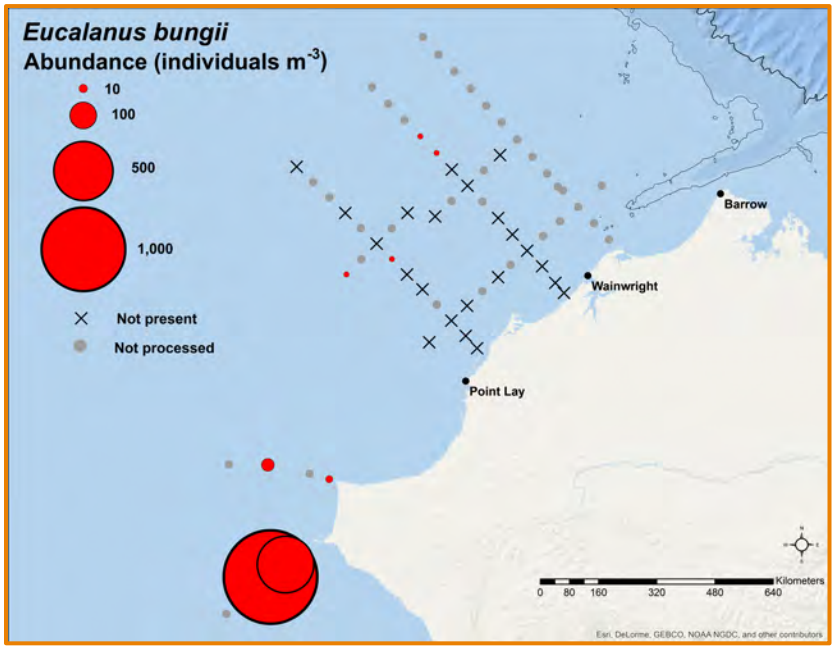
Trace numbers of ice-associated taxa: *Tisbe* and *Cyclopina*



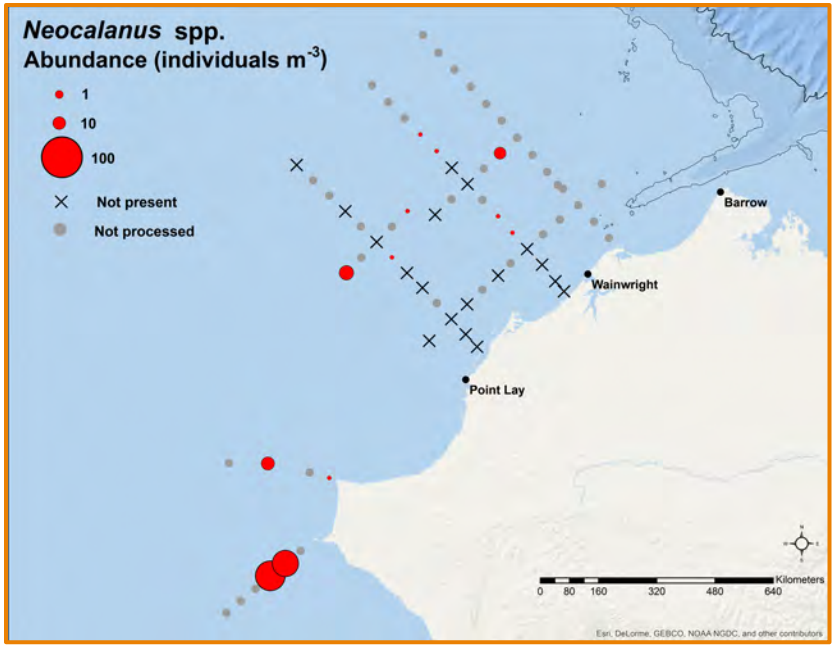


Large-bodied copepods

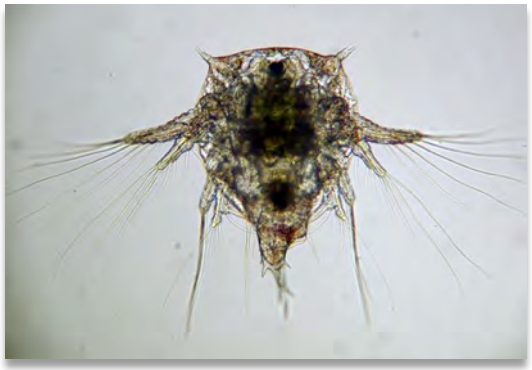


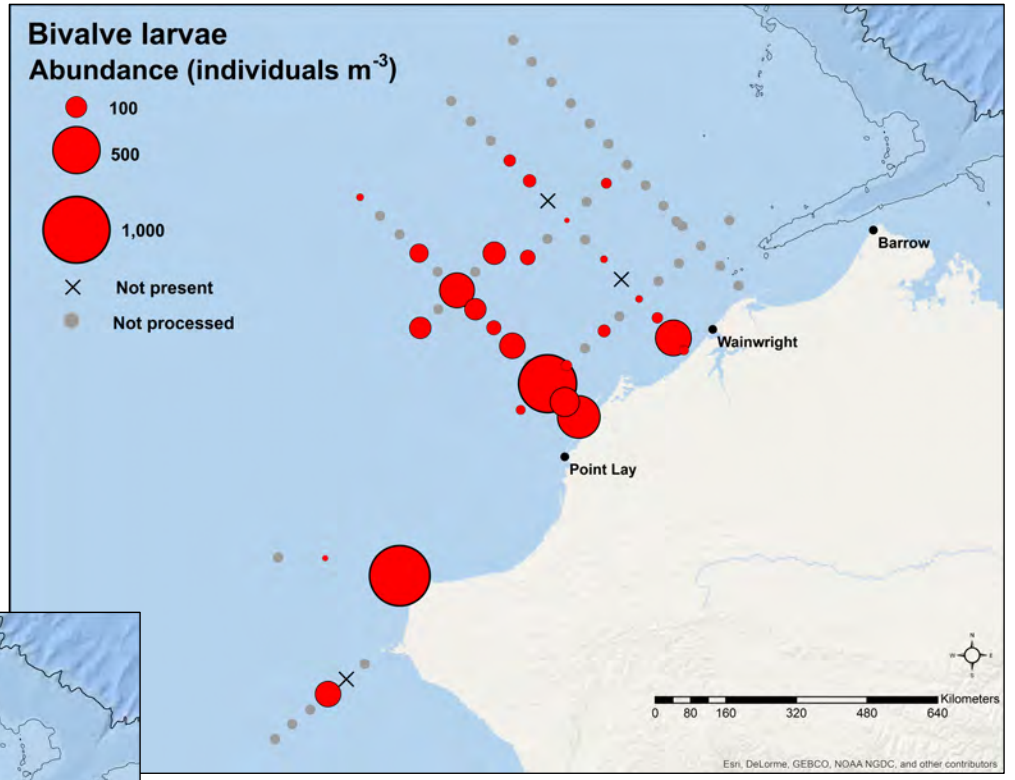


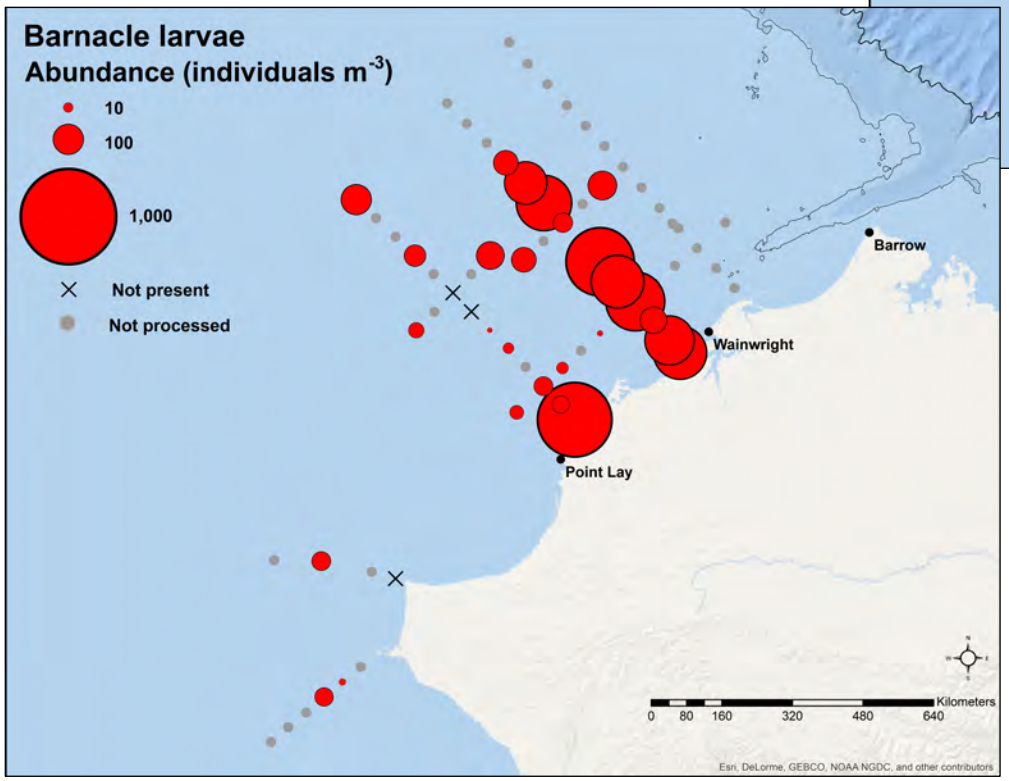
Pacific expatriates



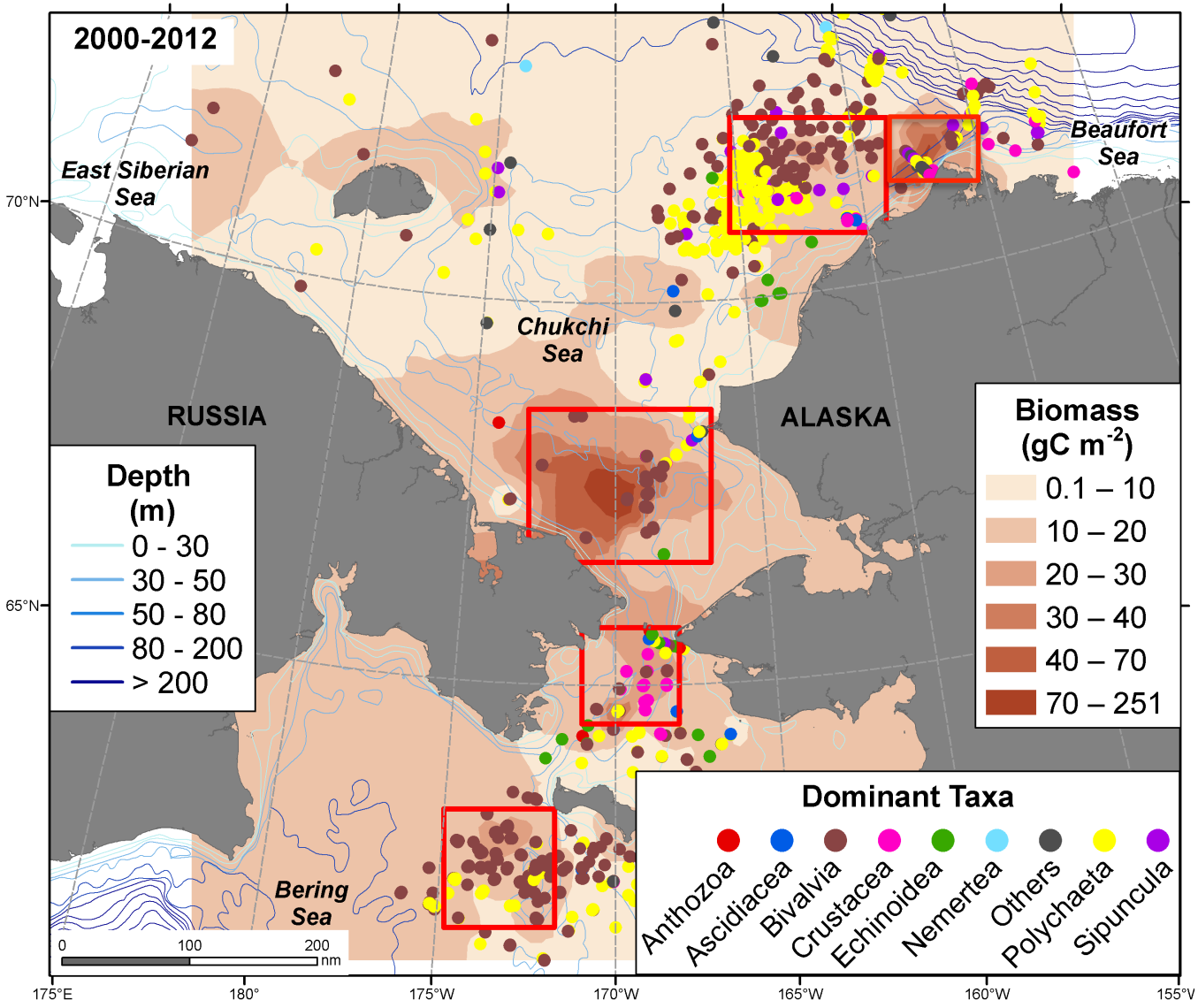
Meroplankton







Rich benthic communities on the western side of the Bering/Chukchi Sea system 2000-2012 (AMBON15 identifications in progress)



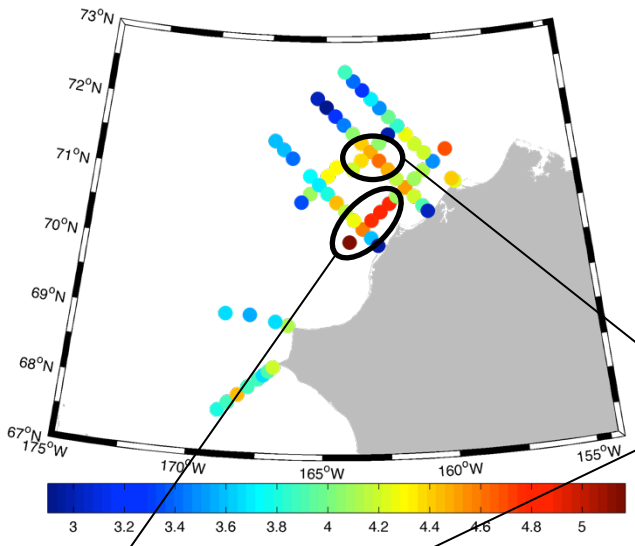
[modified from Grebmeier et al. 2015, Prog. Oceangr.]

- **"foot prints"** of high benthic biomass reflect pelagic-benthic coupling and export of carbon to sediments
- infauna dominated by amphipods, bivalves, polychaetes, and sipunculids

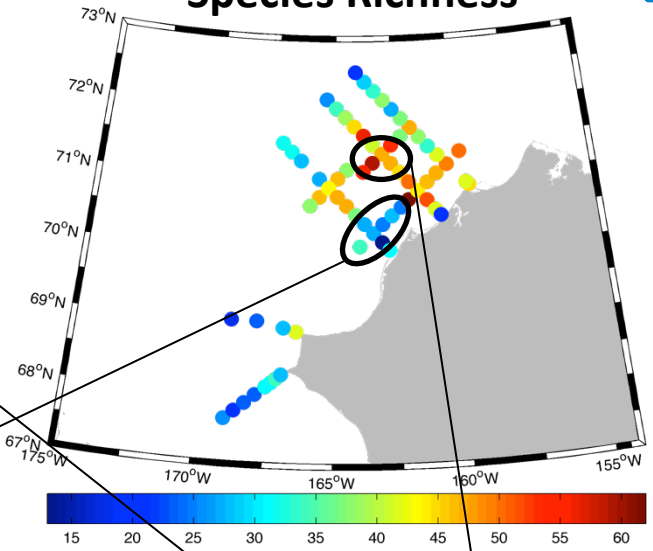
Epifauna

2015

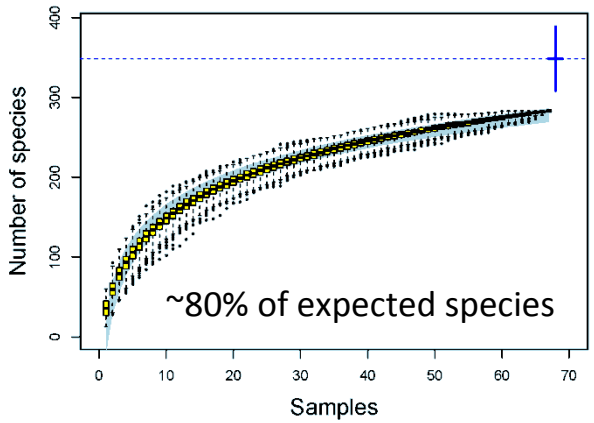
Biomass



Species Richness



High biomass – low diversity



High biomass – high diversity

AMBON 2015

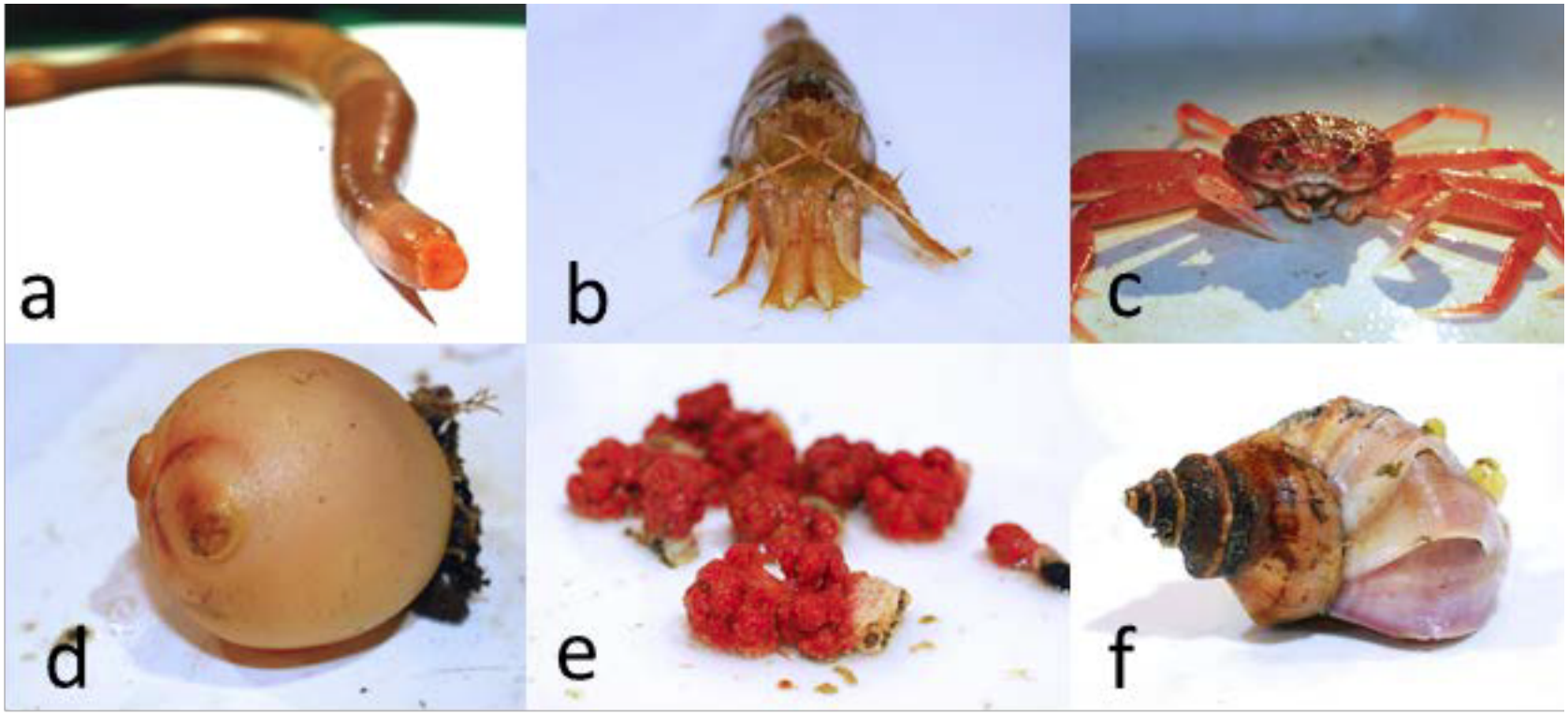


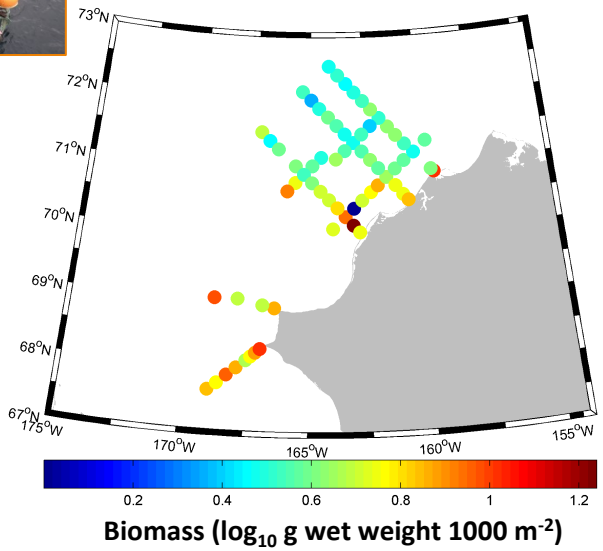
Figure 19: Invertebrates collected to investigate for associated microbes: a. Golfingia margaritacea (Sipuncula); b. Argis sp. (Decapoda); c. Chionoecetes opilio (Decapoda); d. Halocynthia aurantium (Ascidiacea); e. Gersemia rubiformis (Cnidaria); f. Neptunea heros (Gastropoda).

[courtesy Katrin Iken]

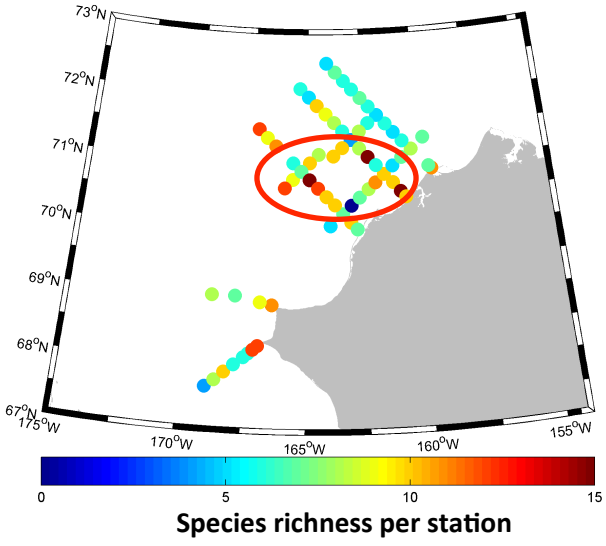
Demersal fish

2015

Biomass

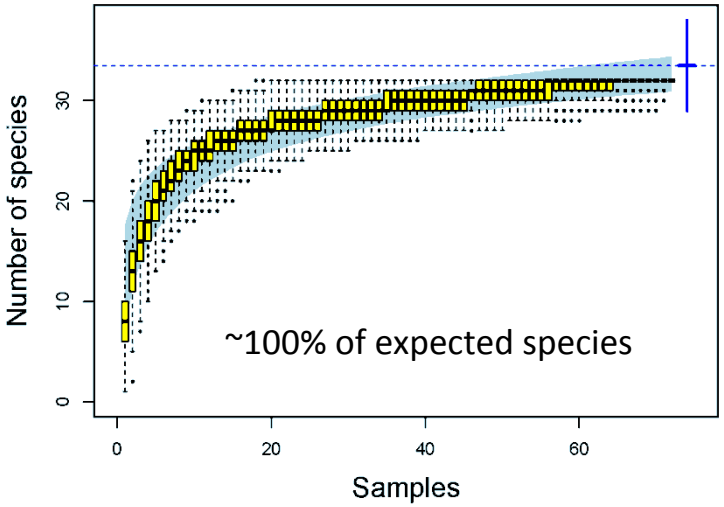


Species Richness



- Highest biomass in coastal regions

- Highest diversity in central region
- Sculpins, pricklebacks, cods, sandlance



Seabird Distribution & Abundance in the Chukchi Sea

Principal Investigator: Kathy Kuletz *(U.S. Fish & Wildlife Service)*

Observer & analysis: Dan Cushing *(Polestar Ecological Research LLC)*

Observer: Catherine Pham *(Grad Student; Hawaii Pacific Univ.)*

Data Management: Elizabeth Labunski (*U.S. Fish & Wildlife Service)*

Methods:

Visual surveys using protocol, distance sampling, 300m width

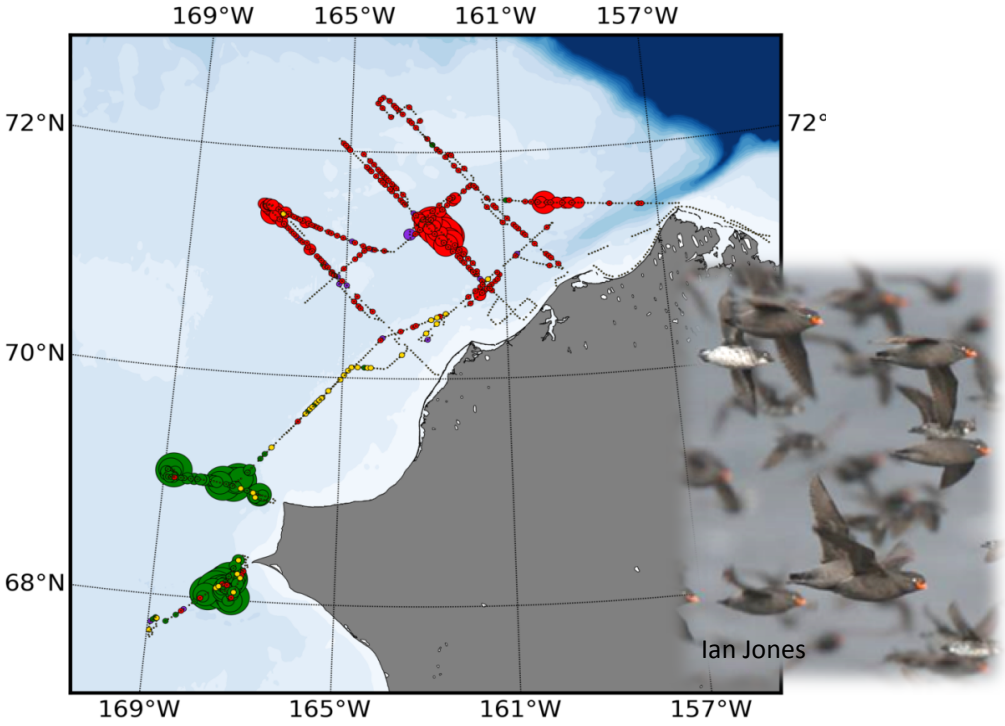
Calculate densities (#/km^2); 3-km segments; 40x40km cells

Examine Community, Key species, and Environmental Drivers

M. Rauzon

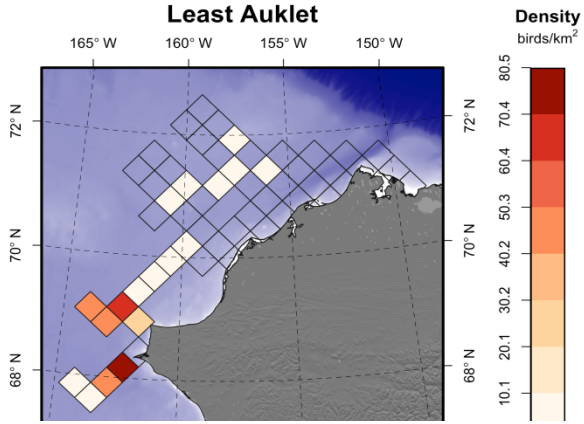
Niche separation within genera

Example: *Aethia* auklets

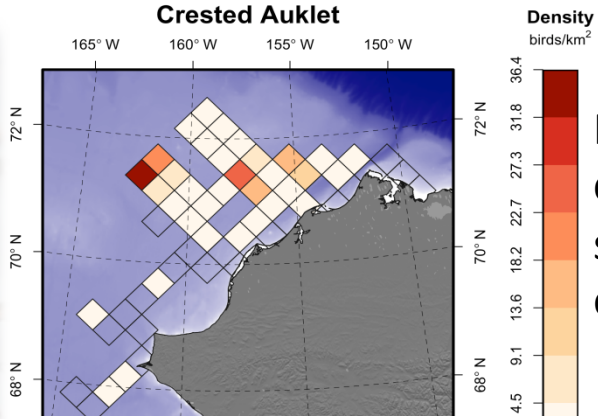


Corrected Densities in 40x40 km cells

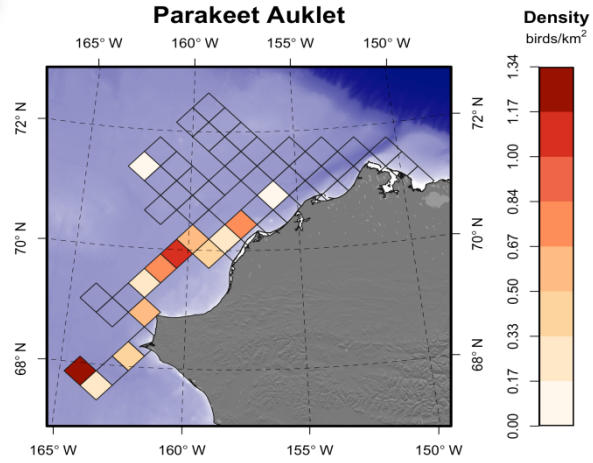
DIET



Sm-med copepods



Med-large copepods, some euphausiids



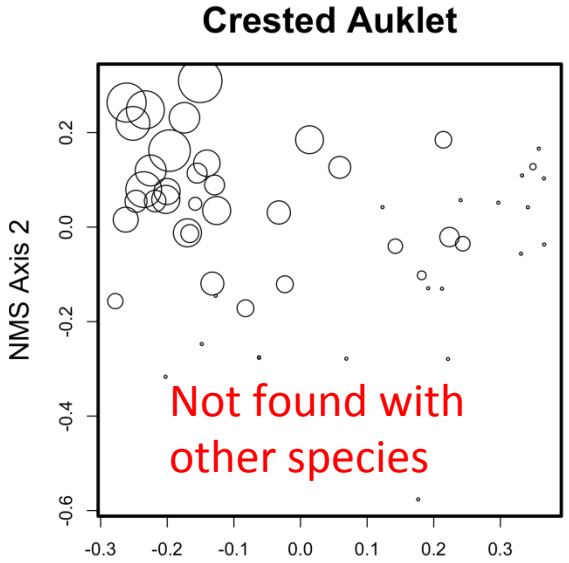
Copepods, euphausiids sm fish

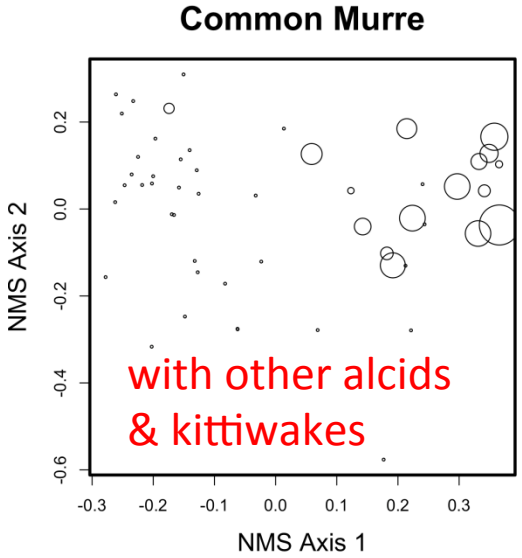
Preliminary Seabird Community Analysis

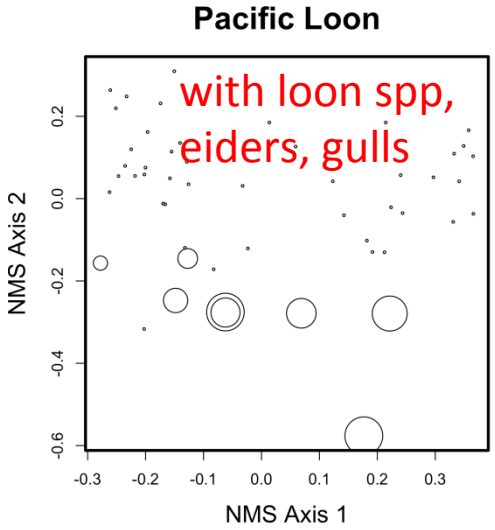
Strongest environmental variables: SST & Dist. offshore

Offshore

Nearshore





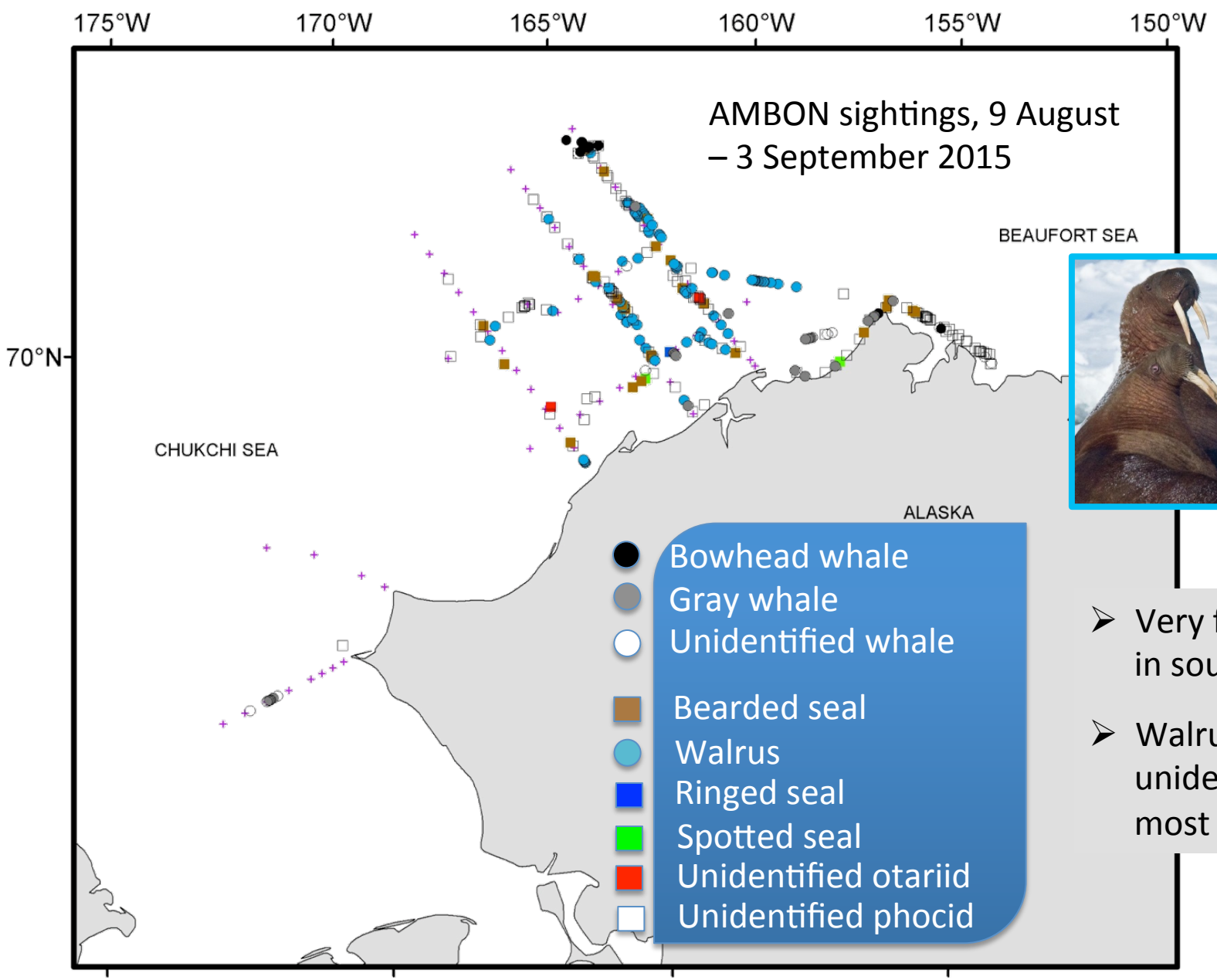


Colder

Warmer

Marine Mammals

2015



- Very few mammals in southern region
- Walrus and unidentified phocids most common

Experimental Setup-Live clam acidification experiments AMBON/DBO

[Christina Goethel, MS candidate, Marine Estuarine and Environmental Sciences Program, University of Maryland - Chesapeake Biological Laboratory]

Macoma calcarea

Successes and challenges for AMBON

Successes

- AMBON field program 2015: good progress on sample processing, data generation and archive development

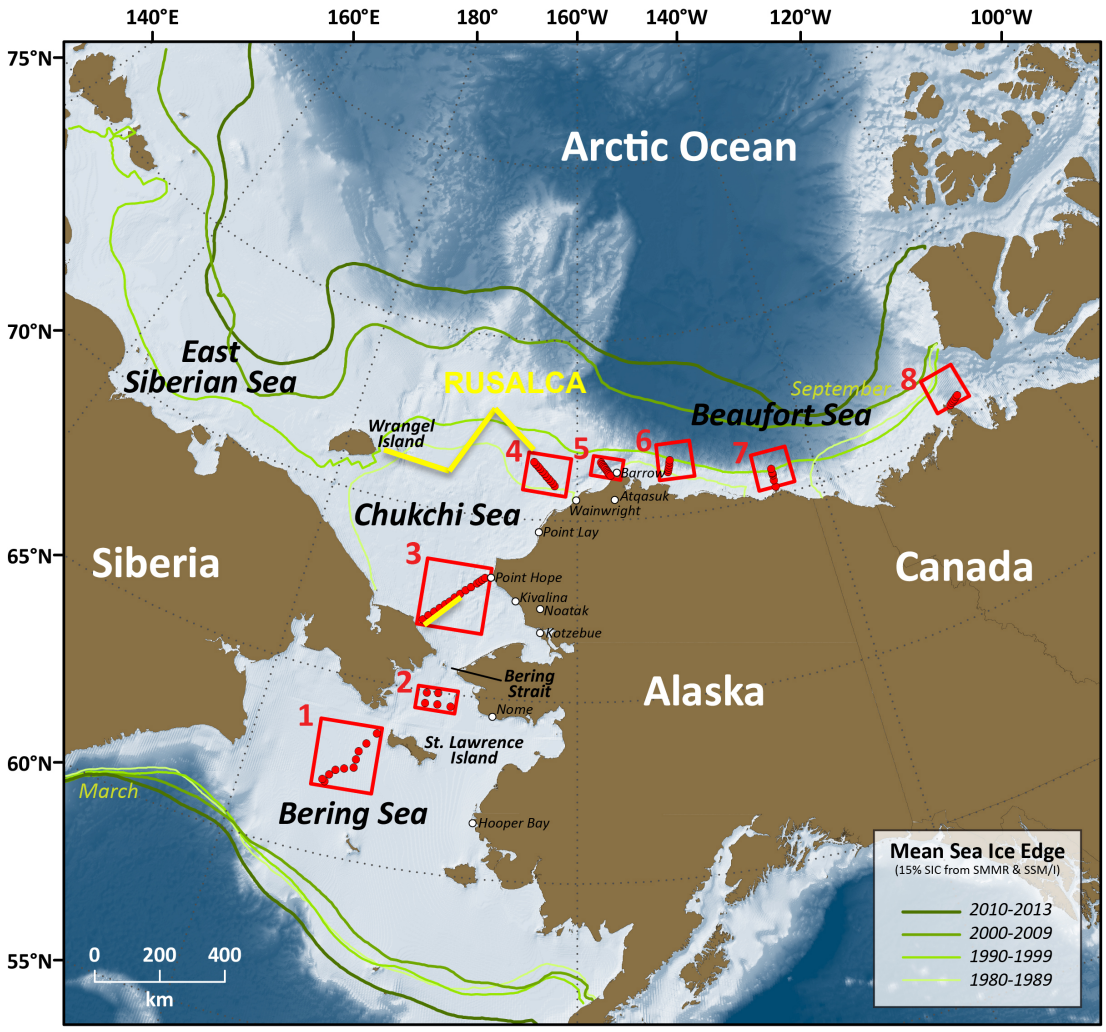
Challenges

- End of Shell funding in 2015; cancelled 2016 cruise, all PIs reduced budgets for Years 2-5, 2017 field program will have to be scaled to available funds

- Norseman 2- well-equipped for our field sampling, but limited in size; industry request for 12-hour seabird/marine mammal sampling required longer period at sea

    - Seabirds - ~ 8-15 species appropriate for scaling distribution/abundance relative to variables across study area
    - Benthivores (e.g. walruses, diving ducks, bearded seals) not well represented due to mostly offshore effort (some could be made up with data from other studies)
    - AMBON surveys appropriate for determining relative abundance (densities), distribution, biodiversity; not suitable for population estimates
    - Good linkages for tying species distribution and community composition to relevant environmental & prey data (particularly for more abundant species)

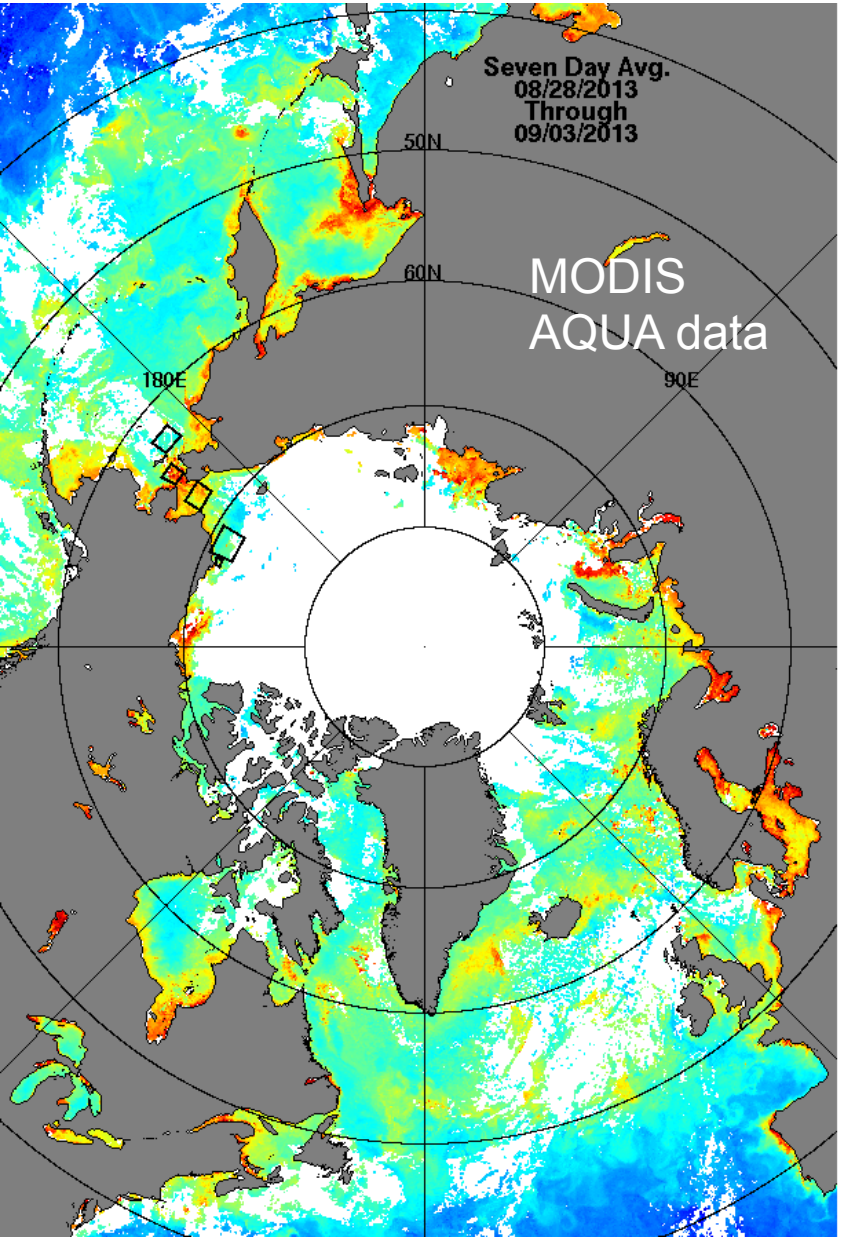
Linking Physics to Biology: the Distributed Biological Observatory (DBO)

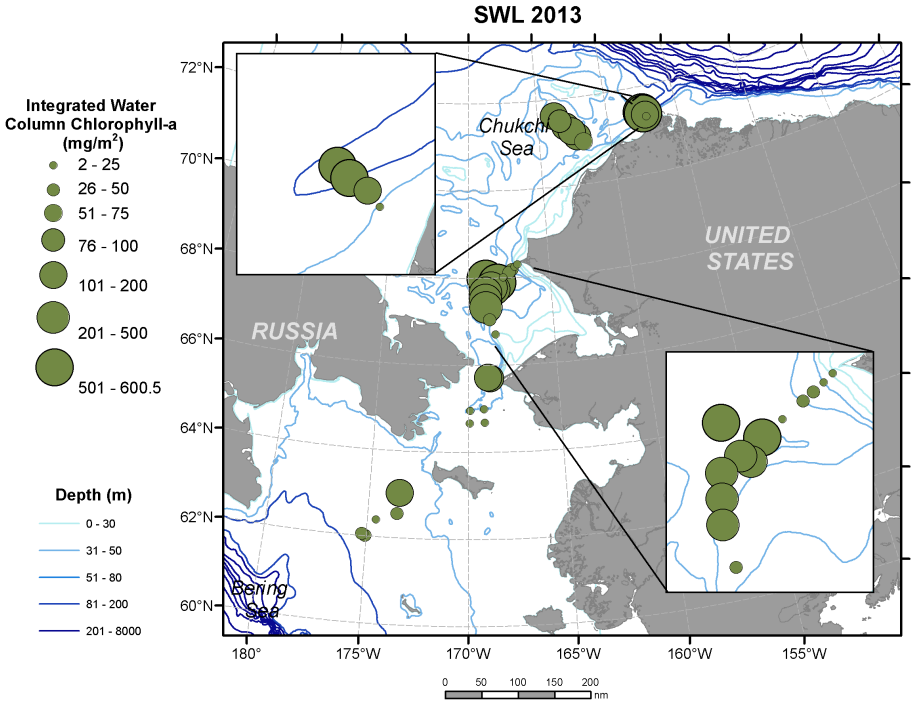


[modified by Karen Frey from Grebmeier et al. 2010, EOS 91]

- DBO sites (red boxes) are regional "hotspot" transect lines and stations located along a latitudinal gradient (DBO1-5) and longitudinally (DBO6-8)
- DBO sites exhibit high productivity, biodiversity, and/or overall rates of change
- DBO sites serve as a change detection array for consistent monitoring of biophysical responses
- Sites occupied by national and international entities with shared data plan

NASA surface chlorophyll versus field collected intregated values





- Highest chl a via satellites and field data in Bering Strait and offshore SE Chukchi Sea DBO3 SE Chukchi Sea hotspot

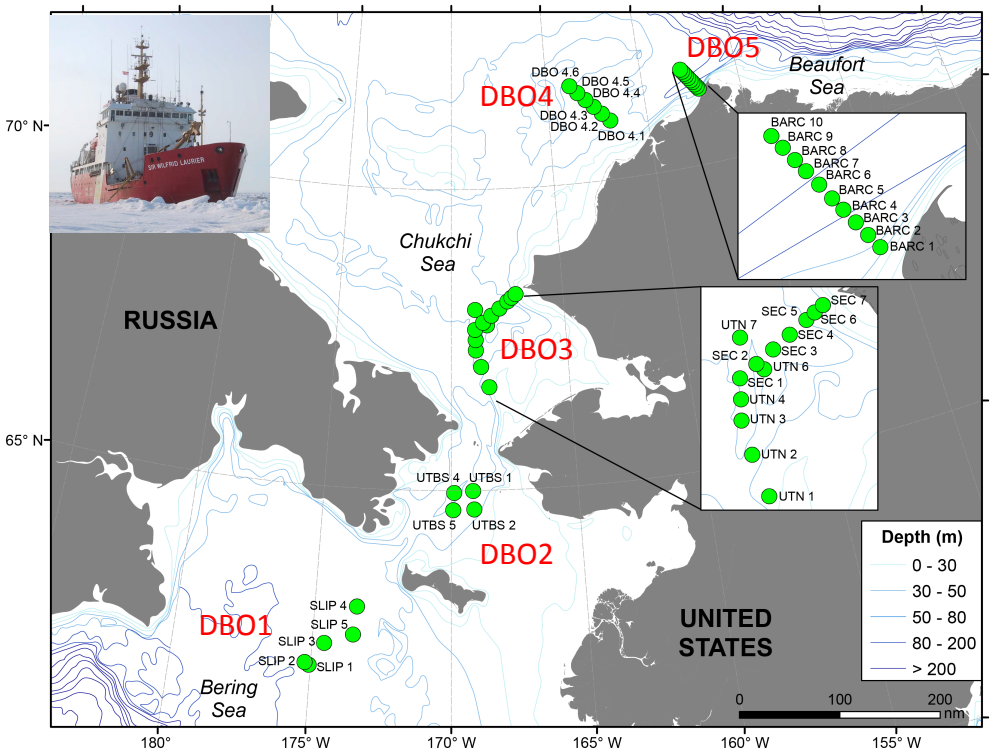
- Use AMBON and DBO field data for calibration studies with NASA

J. C. Comiso, Karen Frey, L. V. Stock, R. A. Gersten, and H. Mitchell, NASA collaborators

http://neptune.gsfc.nasa.gov/csb/index.php?section=270

Canada's Three Oceans (C30) and the Distributed Biological Observatory (DBO): *CCGS Sir Wilfrid Laurier*, July 10-22, 2016

Focus: sampling along latitudinal transect lines developed as a "change detection array" for consistent monitoring of biophysical responses to changing environmental conditions



Estimated Timeline:

- July 14-south St. Lawrence Island (DBO1)
- July 15-Chirikov Basin (DBO2)
- July 17: SE Chukchi Sea (DBO3)-closest station 5 nm from coast, estimate time within 12 nm to be 2 hrs
- July 19: NE Chukchi Sea off Wainwright (DBO4)-closest station 30 nm offshore
- July 20: off Barrow (DBO5)-closest station 5 nm from coast, estimate time within 12 nm to be 2 hrs

DBO data collections

- Seawater temperature and salinity; velocity measurements
- Nutrients, chlorophyll, carbon products, CDOM
- Phytoplankton, zooplankton and macrobenthic abundance, biomass, community structure
- Marine mammal and seabird surveys

Contact: Dr. Svein Vagle, Canadian Chief Scientist, Jackie Grebmeier, UMCES and PAG,
jgrebmei@umces.edu

www.arctic.noaa.gov/dbo/

Korean 2016 Arctic cruise plan (August), including DBO3 that will also be occuppied by Japan and China

Contact: Dr. Eun Jin Yang, Chief Scientist ejyang@kopri.re.kr;
Pacific Arctic Group US contact: Jackie Grebmeier jgrebmei@umces.edu

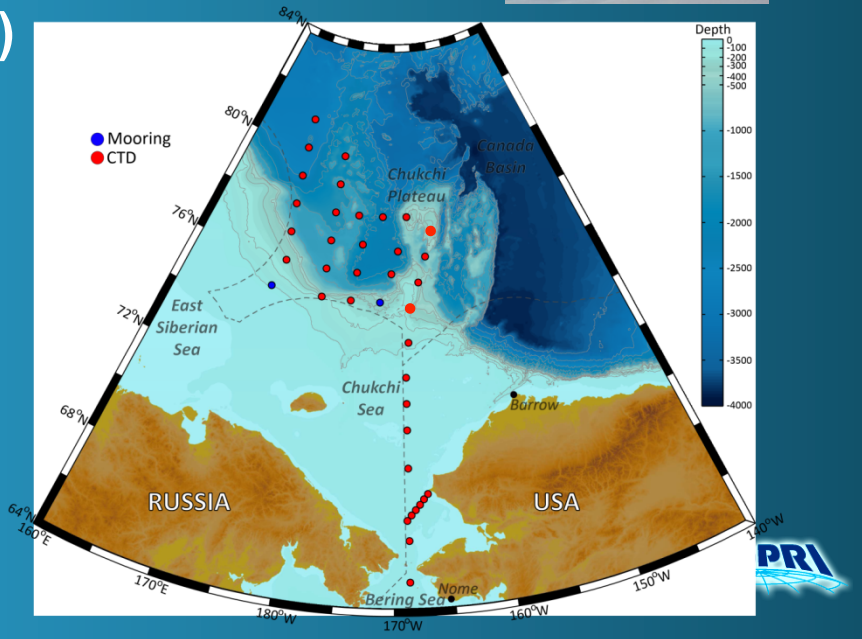
- **Aims of the cruise:**

  - To investigate the structure and processes in the water column and subsurface (sediment) around the northern Bering Sea, Chukchi/East Siberian Seas in rapid transition .

  - To understand the sea ice dynamics and sea ice ecosystem

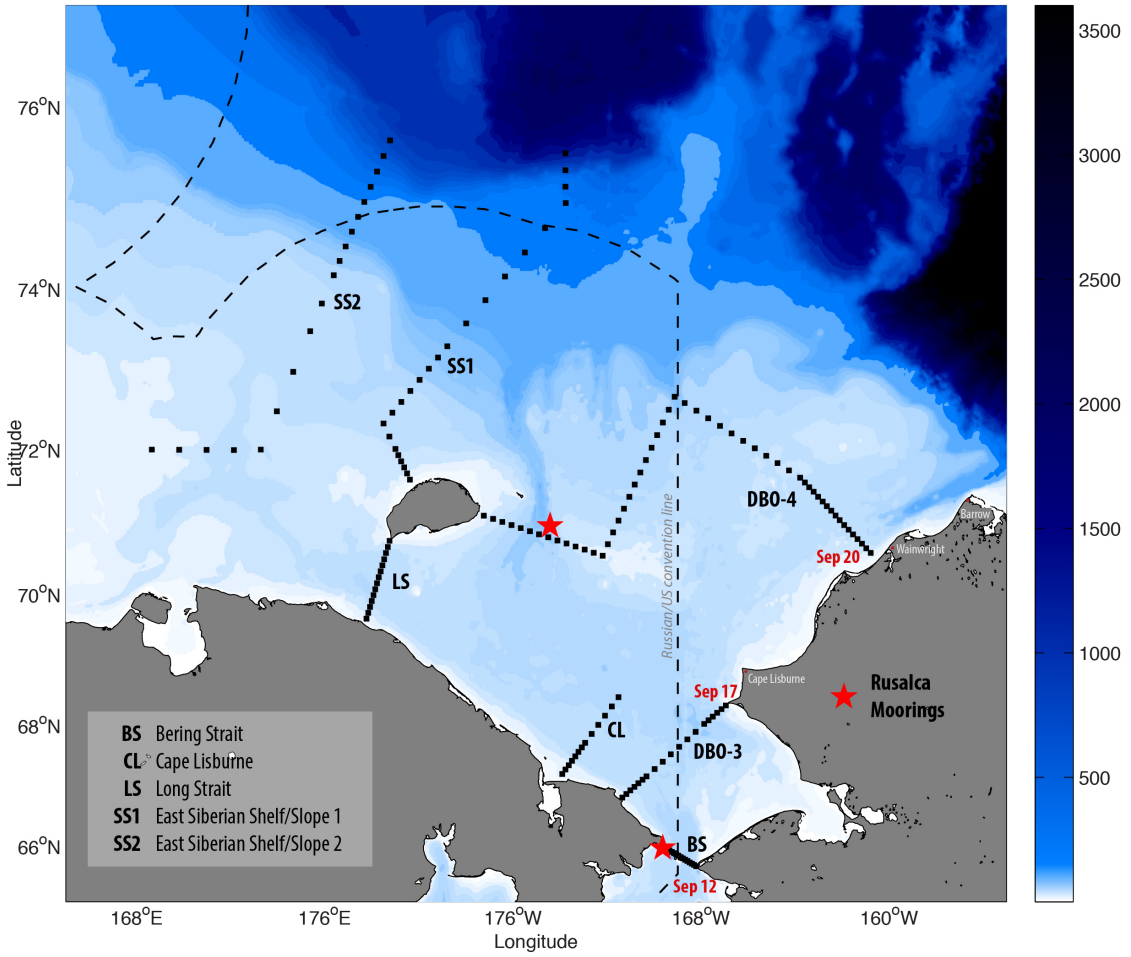
- **Period:** 2016. 8.3 ~ 8. 19 (ca. 16 days)

- **Research fields:**
  - Atmospheric observation
  - Satellite remote sensing
  - Microbes & plankton ecology
  - CO_2 systems in water column
  - Hydrographic survey
  - KOPRI mooring stations (2 sites)
  - Sea ice dynamics & ecosystem



Russian-American Long-term Census of the Arctic (RUSALCA) 2016 cruise *RV Victor Buynitskiy*, Sept 10-30, 2016

RUSALCA Contract: Jackie M. Grebmeier, Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, Solomons, MD 20688, USA; ph. 410-326-7334, fax 410-326-7302; email: jgrebmei@umces.edu.



- Including DBO3 and DBO4

Field Measurements:

- Physical: CTD and lowered ADCP, moorings
- Chemical: nutrients, oxygen-18, chlorophyll-a (Chl a),
- Biological: zooplankton (abundance and biomass, growth rates)
- Benthos: macrobenthos abundance, biomass and population structure,
- Sediment: organic carbon/nitrogen content, chl a content ,grain size, Cs-137 and Pb-210 content; benthic oxygen uptake and nutrient exchange
- Upper trophic: marine mammal shipboard surveys, passive acoustics on moorings

Successes and challenges for "Cross-MBON"

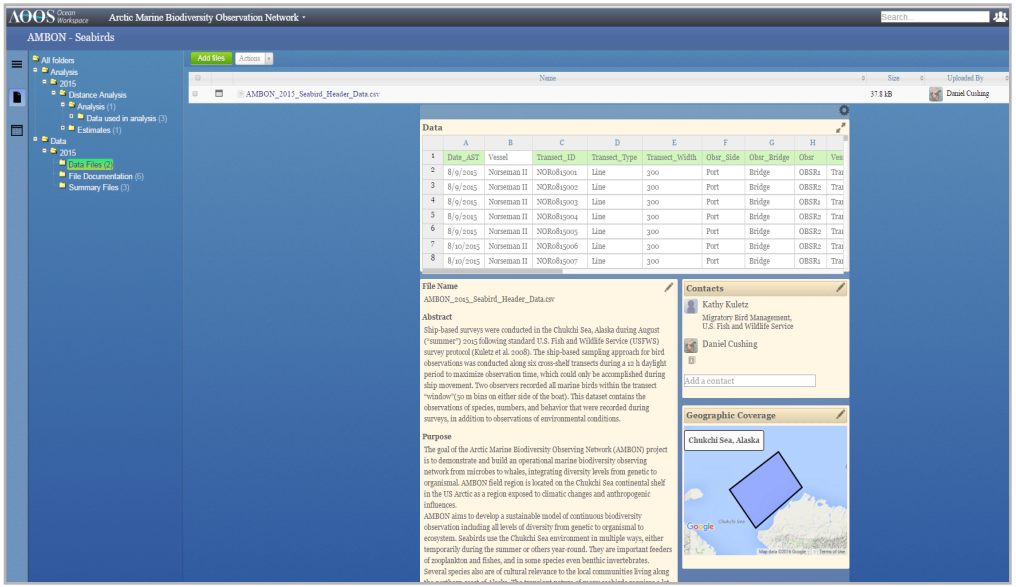
Integration

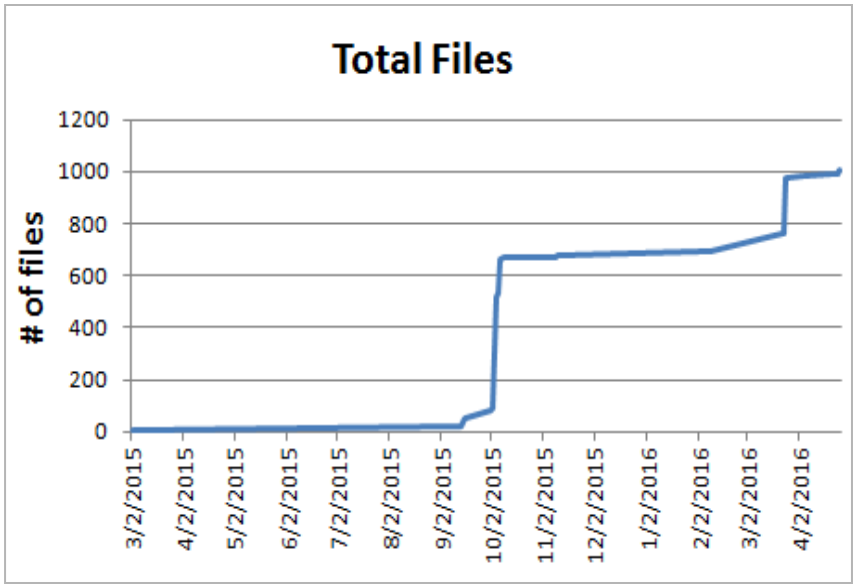
- Joining Chukchi Sea data streams @AOOS.org
- Role recognized in international Arctic programs (CBMP, PAG, ESSAS)
  - Circumpolar Biodiversity Monitoring Programme (Arctic Council)
  - Pacific Arctic Group (Korea, China, Canada, USA, Russia, Japan)
  - Ecosystem Studies of Subarctic Seas (regional program of Integrated Marine Biogeochemistry and Ecosystem Research)
- Need to Grow Coordination with other MBONs
  - Florida Keys and Monterey Bay Sanctuaries MBON
  - Channel Islands MBON
- Provide model for operational marine biodiversity observation network
- Essential Biodiversity Variables (EBV)
- Common methodologies to support concept and promote integrations

Arctic biodiversity from microbes to whales

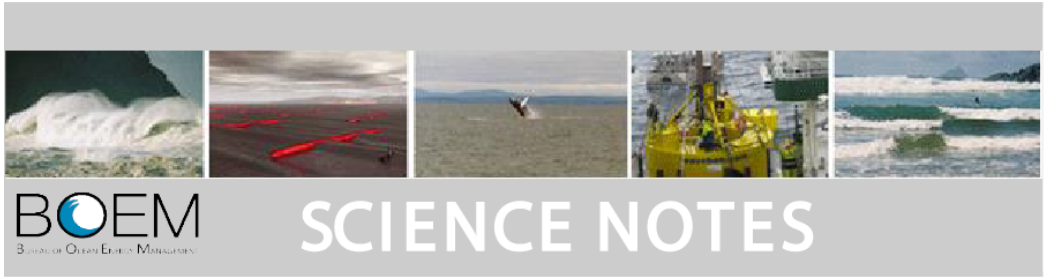
Data management:

- Ocean Workspace: web-based data storage & sharing tool
- 2015 data: >1,000 AMBON files (1.2 Gb) uploaded
  - 7 projects (55%) complete 2015 data with primary analyses
  - All 2015 data with preliminary metadata documentation
- AOOS public data portals & AMBON website: team can publish 2015 data through Workspace gateway





Outreach Efforts



April 8, 2016

Dear Reader:

This month's Science Note presents new findings from the 2015 field season of the Arctic Marine Biodiversity Observing Network study, or AMBON. Last August, researchers began monitoring biodiversity in the Arctic Chukchi Sea from an ecosystem perspective, looking at microbes, whales and everything in between. BOEM is supporting this study to enhance environmental impact assessments and develop better metrics for cumulative impact analysis and a broader perspective of the ecosystem. To learn more, please enjoy reading this month's Science Note, and feel free to send us your feedback at boempublicaffairs@boem.gov.

Sincerely,
William Y. Brown
Chief Environmental Officer, Bureau of Ocean Energy Management

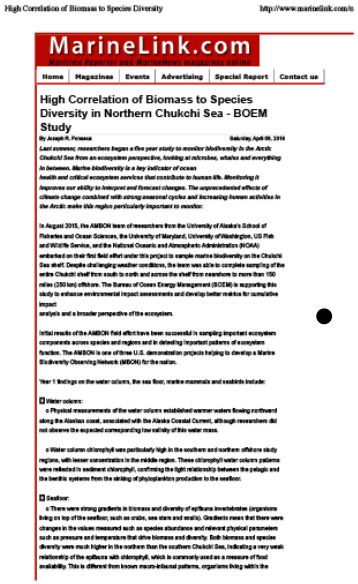
Arctic study finds high correlation of biomass to species diversity in northern Chukchi Sea

Initial research of Chukchi shelf examines water column, bottom fish, invertebrates, walruses, and seabirds

University and federal researchers sort through crabs, sea stars and mussels collected from the Chukchi Sea seafloor in 2015 for the AMBON partnership study. Photo credit: Katrin Iken, University of Alaska Fairbanks

Last summer, researchers began a five year study to monitor biodiversity in the Arctic Chukchi Sea from an ecosystem perspective, looking at microbes, whales and everything in between. Marine biodiversity is a key indicator of ocean health and critical ecosystem services that contribute to human life. Monitoring it improves our ability to interpret and forecast changes. The unprecedented effects of climate change combined with strong seasonal cycles and increasing human activities in the Arctic make this region particularly important to monitor.

In August 2015, the AMBON team of researchers from the University of Alaska's School of Fisheries and Ocean Sciences, the University of Maryland, University of Washington, US Fish and Wildlife Service, and the National Oceanic and Atmospheric Administration (NOAA) embarked on their first field effort under this project to sample marine biodiversity on the Chukchi Sea shelf. Despite challenging weather conditions, the team was able to complete sampling of the entire Chukchi shelf from south to north and across the shelf from nearshore to more than 150 miles (250 km) offshore. The Bureau of Ocean Energy Management (BOEM) is



- Press release incorporated into BOEM Science Notes followed by distribution on the web and in social media

White House FACT SHEET (September 1, 2015): President Obama Announces New Investments to Enhance Safety and Security in the Changing Arctic

Launching a demonstration project for Arctic marine-biodiversity observing. This year, the Arctic Marine Biodiversity Network (AMBON) will launch the first of three sampling cruises (with others to launch in 2016 and 2017) as part of a five-year demonstration project. These cruises will gather a broad range of Arctic marine-biodiversity data, including bird and mammal observations, water-column analysis (temperature, salinity, chlorophyll-a extraction, nutrients, etc.), and information on microbes and small eukaryotic plankton, zooplankton, sediment cores, and fishes.

https://www.whitehouse.gov/the-press-office/2015/09/01/fact-sheet-president-obama-announces-new-investments-enhance-safety-and

Acknowledgements

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NOAA

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